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History of the Space Age

By Anne Millbrooke

In 1947 Robert A. Heinlein published *Rocket Ship Galileo*, a "science fiction adventure," about four American astronauts who flew to the Moon, where they found and fought Nazis. Theirs was by no means the first fictional space trip. Jules Verne's *From the Earth to the Moon* (1865) and H.G. Wells' *First Men in the Moon* (1901) had long been classics. Heinlein's book became the inspiration for the 1950 movie *Destination Moon* set firmly in the postwar Cold War: the race to the Moon was a military arms race. In the movie the fictional General Thayer explains that "there is absolutely no way to stop an attack from outer space" so "the first country that can use the Moon for the launching of missiles will control the Earth."[1] In fact, the Cold War defined much of the early Space Age from the World War II and postwar work on missiles and rockets to satellites and other space vehicles — in the United States and in the Soviet Union. Only as the Soviet Union and Cold War crumbled did other countries develop significant space flight programs.

The Space Age as a historical era coincided with the Cold War, and that is no coincidence. The atomic bomb dropped on Hiroshima in 1945, the successful launch and orbits of the Soviet satellite *Sputnik* in 1957, Soviet cosmonaut Yuri Gagarin becoming the first person in space in 1961, American astronauts landing and walking on the Moon in 1969, the various space stations and space transportation systems developed thereafter, and other

Space Age events happened in the context of the Cold War rivalry between the United States and the Soviet Union, allies of these two Superpowers, and the unaligned nations (Third World) whose allegiance both sides sought. The Space Age, defined by space travel, continued after the explosion of the space shuttle *Columbia* in 1986, the fall of the Berlin Wall in 1989, and the collapse of the Soviet Union in 1991, but without the direction and funding of the military imperative of the Cold War space rivalry, nor the popular and political support of earlier times, but with an increased number of nations seeking international stature and scientific and technical development through space programs.

A popular "age" is a period generally recognized by the public. For the Space Age the initial public awareness came in 1957 with the Soviet launch of the satellite *Sputnik.* That event marks the transition of space flight from science fiction to science fact, albeit not the end of science fiction by any means, as amply illustrated by the subsequent popularity of the three *Star Wars* movies, the later three prequel *Star War* movies, the several *Star Trek* television series, and *Star Trek* movies.[2]

Sputnik

The Soviet Union launched the first *Sputnik* satellite in early October 1957. The next day the Soviet newspaper *Pravda* reported, "As a result of very intensive work by scientific research institutes and design bureaus the first artificial satellite in the world has been created. On October 4, 1957, this first satellite was successfully launched in the USSR. According to preliminary data, the carrier rocket has imparted to the satellite the required orbital velocity of about 8000 meters per second."[3] It was the carrier rocket, an R-1 military rocket, as much as the satellite that caused much of the concern in the First World, the Free

World, the West. The fact that the Union of Soviet Socialist Republics — a member of the Second World, the Communist World, the East — had a rocket that powerful and had achieved a space flight before the West suggested a Soviet lead in the scientific and technological arms race. Indeed, there was fear that the Soviets would develop the capability to attack the United States from outer space, or at the least that the powerful Soviet rockets might be used to launch intercontinental missiles.

In 1957 the Soviets did more than launch the world's first artificial satellite. On November 3, 1957, they successfully launched their second satellite, *Sputnik II*, with a dog named Laika on board. Then, on December 6, the United States failed to launch the Navy's Vanguard rocket with a satellite on board. Finally, on January 31, 1958, an Army team, led by the German immigrant Wernher von Braun, succeeded in launching the first American satellite, *Explorer I*, on a Jupiter-C rocket. Although the early satellite launches of both the United States and the Soviet Union were part of formal, published programs of the International Geophysical Year of 1957-1958, the actual success of *Sputnik* brought what had been quiet military rocket programs to the public attention as a space race. The *Explorer* carried scientific instruments that allowed the discovery of radiation belts named after the scientist James A. Van Allen. As Van Allen later recalled, "We were treated like heroes, rescuing the honor of the United States in this great Cold War with Russia by having a successful satellite."[4]

Just as the Atomic Age had inspired "Atomic" cafes, "Atomic" cocktails, and even bikini swimwear (too hot to handle, like the Bikini nuclear test site in the Marshall Islands), the Space Race acquired a public language of its own. *Flopnik*, for example, became the derisive term applied to the United States' first and failed launch of a rocket with a satellite

on board. Spookniks became a term for the spying possibilities of Soviet satellites. The Atomic Age and the Space Age merged at the thought that one or the other Superpower might deliver an atomic bomb from a space-launch-capable rocket, a spacecraft, or a space base.

Among the consequences of *Sputnik* was the development of satellite communications, both commercial and defense systems.[5] A significant consequence was the establishment in 1958 of two space agencies in the United States, one civilian and one military. The National Aeronautics and Space Administration (NASA) and the Advanced Research Projects Agency (ARPA) became part of the growing Cold War military-industrial complex. NASA, for example, acquired not only the programs of the National Advisory Committee for Aeronautics (NACA), but also the Navy's Vanguard rocket program and the Army's Explorer rocket program. According to a NASA chief historian (Roger D. Lanius), "First, NASA's projects were clearly cold war propaganda weapons that national leaders wanted to use to sway world opinion about the relative merits of democracy versus the communism of the Soviet Union. … Second, NASA's civilian effort served as an excellent smoke screen for the DOD's military space activities, especially for reconnaissance missions."[6] The Soviets used their space programs similarly.

Space Flight

The romance of flight, whether of birds, balloons, or airplanes, extended with spacecraft into outer space, but space flight remained experimental through many projects, including the Soviet one-person Vostok (East), two-person Voshkod (Rise), and lunar Soyuz (Union) programs, and the American one-person Mercury, two-person Gemini, and lunar

Apollo programs. Using the one-person capsules, both nations acquired valuable experience, one astronaut at a time, orbiting the Earth, and integrating man and machine, the machine being not only the spacecraft but also the spacesuit and mission equipment. As spacecraft got large enough to carry two people, the nations experimented with an extravehicular activity that quickly became known as a spacewalk. Early in 1965 the Russian astronaut Alexei Leonov had made the first spacewalk in history, tethered to a Voskhod capsule. Good publicity followed for the Soviet Union. Three months later American astronaut Edward H. White accomplished the first American spacewalk, tethered to a Gemini capsule, but also using a Hand-Held Maneuvering Unit (HHMU). Good publicity followed for the United States. Such was the propaganda value of the space programs.

Figure 1: Yuri Gagarin on the launch pad before becoming the first person in space, April 12, 1961. Credit: NASA

Figure 2: With a Hand-Held Maneuvering Unit in his right hand, Edward White performs extravehicular activity (a spacewalk) outside the *Gemini 4* spacecraft. Credit: NASA.

Initially, the Soviets seemed to be ahead in the Space Race: first satellite — *Sputnik*, October 4, 1957; first animal in space — the dog Laika, November 3, 1957; the first man in space — Yuri Gagarin, April 12, 1961. In May 1961 President John F. Kennedy acknowledged the Soviet lead, attributed it to their big rockets, and predicted it would continue for a while. But he had a plan to overtake the Soviets and achieve leadership in space. He announced, "Finally, if we are to win the battle that is now going on around the world between freedom and tyranny … Now it is time to take longer strides — time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on earth."[7] He continued, "We go into space because whatever mankind

must undertake, free men must fully share." Kennedy concluded, "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth."

But, as Kennedy predicted, the Soviets continued to capture headlines with their space achievements:

- first woman in space — Valentina Tereshkova, June 16, 1963;
- first spacewalk — Alexei Leonov, March 18, 1965;
- first soft landing on the Moon — the probe *Luna 9*, February 3, 1966;
- first automatic docking in space — unmanned *Kosmos 186* and *Kosmos 188*, October 30, 1967; and
- first docking in space of two manned spacecraft — *Soyuz 4* and *Soypz 5*, January 14-15, 1969.
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Whether in control of the ground station or of an astronaut on board, early spacecraft were being flown by test astronauts in the tradition of test pilots. There were accidents through the years, bad accidents in the early lunar tests. Three American astronauts — Virgil "Gus" Grissom, Edward H. White, and Roger Bruce Chaffee — died in a fire during a launch pad test of the *Apollo 1* spacecraft (January 27, 1967). Soon thereafter the Soviets reached a dubious first: first person to die in spaceflight, when the crash of the first Soyuz spacecraft killed Vladimir Komarov (April 24, 1967). These accidents reminded the public of the dangers undertaken in the race to reach the Moon. The Apollo accident review board concluded, "Those organizations responsible for the planning, conduct, and safety of this test failed to identify it as being hazardous."[8] That prompted a redesign of the Apollo capsule

and the Apollo safety program. *Apollo 7* finally achieved the first manned Apollo flight in October 1968, when it orbited the Earth 163 times. *Apollo 8* orbited the Moon. These and other flights tested equipments, systems, and astronauts in preparation for a lunar landing.

Figure 3: The interior arrangement of the Mercury spacecraft, with seating for one. Credit: NASA.

Despite the strong Soviet push under Sergei Pavlovich Korolev, the United States won the race to place a man on the Moon: Neil A. Armstrong, July 20, 1969. The successful *Apollo 11* mission involved a Saturn V rocket as the launch vehicle, the *Columbia* command module that orbited the Moon, and the *Eagle* landing module. Five more Apollo missions reached the Moon: *Apollo 12, 14, 15, 16*, and *17*. Thus between July 1969 and April 1972, twelve American astronauts walked on the Moon. Russian astronauts on the Moon, zero. The Americans had achieved unquestioned leadership in the Space Race.

In addition to manned spaceflight, NASA and the Soviet space program sponsored unmanned programs that sent probes to explore to the moon, planets, solar system.[9] But popular attention focused mostly on the Space Age manned flights. The first Soviet Salyut (Salute) space station entered orbit in April 1971. In all, the Soviets launched nine Salyut modules during the eleven-year program; six Salyuts were research stations and three were military reconnaissance stations. The American Skylab 1, 2, and 3 orbited the Earth in 1973 and 1974. These space stations enabled astronauts of the two countries to spend extended lengths of time in space and to conduct experiments while there. And the stations had enough space for weightless floating inside the spacecraft. That experience expanded with the Soviet Mir (Peace) space stations and the American reusable Space Shuttles.

The Soviets designed a reusable space transportation vehicles, selected the Buran (Snowstorm), even successfully launched an unmanned Buran, but canceled the program. In contrast, the United States produced and operated a fleet of reusable vehicles: *Columbia, Challenger, Enterprise, Discovery,* and *Atlantis.* The *Columbia* was the first to reach orbit, on April 12, 1981. On return, the shuttle became a lifting-reentry vehicle, and astronauts Robert L. Crippen and John W. Young landed the shuttle like an airplane. The *Columbia* made its next flight in November and thereby became the first spacecraft to be reused. Space shuttles thereafter flew missions to recover satellites and to move people and equipment, even spacecraft. In 1983, on Space Shuttle flights, Sally Ride became the first American woman in space and Guion Bluford became the first black astronaut.

Inside these spacecraft, as space writer Harry L. Shipman noted, "Velcro takes the pace of gravity."[10] The discovery of Velcro (the brand name for a hook and loop fastener) derived from the observation that cockleburrs' hooks stuck in the hair loops of the inventor's dog. That inventor, George de Mestral, received a patent in 1955 — in time for Space Age applications, literally in space. Astronaut Joseph P. Allen traveled into space on the Space Shuttles *Columbia* and *Discovery*. He described the experience:

> During the first few days in space, the act of simply moving from *here* to *there* looks so easy, yet is challenging. The veteran of zero gravity moves effortlessly and with total control, pushing off from one location and arriving at his destination across the flight deck, his body in the proper position to insert his feet into Velcro toe loops and to grasp simultaneously the convenient handhold, all without missing a beat in his tight work schedule. In contrast, the rookies sail across the same path, usually too

> fast, trying to suppress the instinct to glide headfirst and with vague swimming motions. They stop by bumping into the far wall in precisely the wrong position to reach either the toe loops or the handholds.[11]

The reusable Space Shuttle carried Manned Maneuvering Units (MMUs) on three flights, and six astronauts wore the backpack units, a la Buck Rogers, on a total of nine sorties for a total of ten hours and 22 minutes in 1984. Bruce McCandless became the first person to flight free, untethered in space, when he wore a MMU in February. He described the first step off the shuttle, 150 nautical miles above Earth, as "a heck of a big leap."[12] The MMUs were to enable astronauts to perform services outside the shuttle, specifically to recover satellites for repair, but the 1984 sorties were the only time the units were used. The robotic arm replaced the maneuvering unit.

Designed with no escape system, the Space Shuttle program suffered two major disasters. The *Challenger* exploded after liftoff on January 28, 1986. The crew of five men and two women died. According to the Presidential Commission that investigated the accident: "The specific failure was the destruction of the seals that are intended to prevent hot gases from leaking through the joint during the propellant burn of the rocket motor."[13] The *Challenger* had been starting its tenth mission. The first of the space shuttles to enter service in 1981, the *Columbia* went on the 114th shuttle mission in 2003. It reentered the Earth's atmosphere on February 1st. The spacecraft literally fell apart, and the seven astronauts on board died. This time a piece of insulating foam that had broke off the external propellant tank on takeoff and knocked some reinforced carbon insulation off the wing, which then overheated and failed on reentry. The *Columbia* Accident Board concluded that

NASA's culture and history contributed to the accident, because the "agency [was] trying to do too much with too little."[14] The board continued, "The recognition of human spaceflight as a developmental activity requires a shift in focus from operations and meeting schedules to a concern with the risk involved." This brought to many minds the conclusion of early Apollo accident board. Space flight was still developmental.

Beyond the Superpowers

Although Europe was caught between the Superpowers during the Cold War, the nations of Europe tried at times to establish independence from the Cold War rivals. To develop their own technologies, economies, space programs, the European nations cooperated on various programs. The Commission Préparatoire Européenne pour la Rechereche Spatiale (COPERS) started the work toward a European satellite program and a European launch vehicle. Established in 1962, the European Space Research Organization (ESRO) established and operated an satellite program that used American launch vehicles and the Vandenberg launch site in California. Established in 1964, the European Launcher Development Corporation (ELDO) used the British Blue Streak vehicle for the first stage, French technology for the second stage, and German technology for the third, while Italy developed a satellite, and the Netherlands and Belgium worked on tracking and telemetry. Australia joined ELDO when the European organization selected Moomera for the launch test site. The four tests there failed to launch a satellite. ELDO moved launch tests to Kourou, French Guiana, in South America.

The two European collaborations — ESRO and ELDO — merged in 1973. The resulting European Space Agency (ESA) continued the work of developing and operating a

European space program. The European Space Agency selected its first astronauts in 1977. Riding Russian and American spacecraft, European astronauts have visited Spacelab, Mir, and the International Space Station. Why does Europe continue to develop its space program. According to the European Space Agency, "Today's space systems are the key to the understanding and management of the World, to the provision of goods and services in the global marketplace, and to regional and global security and peacekeeping."[15]

The International Space Station is a cooperative program involving the United States, Russia, European Space Agency, Japan, and Canada. A Russian Proton rocket and an American Space Shuttle carried the first two modules into space in 1988, and in 2000 Soyuz spacecraft carried the first crew to reside at the station. As a matter of fact, with the aging of the Space Shuttle fleet, and the groundings after the *Challenger* and *Columbia* accidents, the venerable Soyuz spacecraft have become the workhorses transporting crews, supplies, and equipment to the International Space Station. The Russian Federal Space Agency (Roskosmos) literally sells flights on the Soyuz; the price in January 2006 was just over US $20 million.[16] The Soyuz line has been in service since 1968; the first flight in 1967 ended in the astronaut's death. The current model rendezvous and docks at the International Space Station. Shedding the orbital and service modules for reentry, Soyuz is not reused as only the reentry capsule parachutes to Earth.[17]

Figure 4: Launched from the Baikonur Cosmodrome in Kazakhstan, this Russian Soyuz space capsule is leaving the International Space Station in October 2001. On board are the Soyuz taxi crew, Commander Victor Afanasyev and Flight Engineer Konstantin Kozeev, and a French Flight Engineer named Claudie Haignere who represented the European Space Agency. Credit: NASA.

Since the 1950s, China has had a space program, albeit small initially. As a young communist country, China received space technology and technical assistance from the Soviet Union until 1960. During the 1960s China focused more on developing nuclear weapons than on spacecraft for a while; China detonated its first nuclear bomb in 1964 and first hydrogen bomb in 1967. Yet trade opened with the West, and West Germany provided communication package for a Chinese satellite, the United States provided radiation-hardened electronic chips for Chinese meteorological satellites. In 1966 China decided to pursue human spaceflight, but for years launching satellites remained the main space operation. The Chinese government again approved a human space flight program in 1992, using the country's three satellite launch centers for tests. An unmanned Chinese spacecraft orbited the Earth in November 1999. The Chinese launched a spacecraft carrying animals into orbit in January 2001, unmanned spacecraft into orbit in March 2002 and another in December 2002. China achieved manned spaceflight on October 15-16, 2003, when Yang Liwei rode the *Shenzhou 5* around the Earth 14 times. Among the motivations behind the Chinese space program and the Chinese astronaut Yang was national prestige; as Yang said as he boarded the spacecraft, "I will not disappoint the motherland."[18] He did not disappoint the motherland. China sent two astronauts into space in 2003. A spaceflight and spacewalk are scheduled for September 2008.

India, South Africa, Brazil are among the nations developing space capabilities.

Literature of the Space Age

The American space program, at least the civilian side of it, is well documented, especially by NASA. The NASA History Series includes a four-volume set called *NASA*

Historical Data Book, which covers NASA resources, programs, and projects, 1958-1978.[19] The NASA History Series also includes a six-volume set entitled *Exploring the Unknown, Selected Documents in the History of the U.S. Civil Space Program.*[20] The first director of NASA, T. Keith Glennan, recounts *Birth of NASA.*[21] *"Before This Decade Is Out ..."* is a collection of personal accounts of the Apollo program.[22] The NASA History Series also covers the history of various NASA facilities, like the Johnson, Marshall, and Stennis, space centers, the Langley Research Center, Dryden Flight Research Center, and space programs, like the Mercury, Apollo, Skylab, and Space Shuttle programs.[23]

Many books published independent of NASA also cover the U.S. space program. Autobiograhies present the stories of different participants in the space program. Homer H. Hickam Jr.'s *Rocket Boys* tells of boys inspired by *Sputnik* to build their own rockets.[24] Alan Shepard and Deke Slayton wrote *Moon Shot* about the race to the Moon from the astronauts' perspective.[25] Similarly, biographies provide a wealth of information, like Ernst Stuhlinger and Frederick I. Ordway's two-volume *Wernher von Braun, Crusader for Space.*[26] On the fifth anniversary of the Aerospace Medical Association, Eloise Engle and Arnold Lott wrote an early history of biomedical research, *Man in Flight.*[27] More specific to the space program is John A. Pitts' *The Human Factor, Biomedicine in the Manned Space Program to 1980*, in the NASA History Series.[28] Another example of a book focused on an aspect of the space program is Lillian D. Kozioski's *U.S. Space Gear.*[29] Dennis R. Jenkins provides a thorough overview of the *Space Shuttle* through the first one hundred missions.[30] And there is some literature about the military side of the space program, like the Industrial College's *National Security Management: National Aerospace Programs.*[31]

Some books cover Soviet as well as American space programs. An excellent volume covering the space race in the Cold War context is Walter A. McDougall's *... the Heavens and the Earth, a Political History of the Space Age.*[32] Philip Baker has written *The Story of Manned Space Stations.*[33] Much of the Soviet remains to be told, but a good introduction is James Harford's *Korolev, How One Man Masterminded the Soviet Drive to Beat America to the Moon.*[34]

These are just some examples of vast and growing literature on the Space Age.

Conclusion

No one has visited the Moon since 1972. The Space Shuttle is scheduled for retirement in 2010. Its successor will not be ready until at least 2015. Soyuz spacecraft have been carrying most astronauts to and from the International Space Station, but the Soyuz is an old technology too, older than the Space Shuttle. Spaceplanes remain a popular idea for a 21st-century space vehicle, like NASA's Orbital Space Plane intended to replace the Space Shuttle, and like Scaled Composites' commercially designed *Space Ship One* that won the Ansari X Prize in 2004. Russia has looked at the Klipper (Clipper) winged crew vehicle concept. The European Space Agency launched a new Automated Transfer Vehicle (ATV), a cargo hauler, called *Jules Verne* in March 2008; it went to the International Space Station. Reentry and fiery destruction over the Pacific Ocean are scheduled for late September. Currently unmanned, the one-time-use spacecraft might be further developed for crew capability. As recently as September 2008, NASA Administrator Michael Griffen reminded Congress of the importance of priority and status in what is now an international space environment: "A Chinese landing on the moon prior to our own return will create a stark

perception that the U.S. lags behind not only Russia, but also China, in space."[35] And planetary probes still try to answer the question, are we alone? But national pride, scientific research, and technological development aside, the Cold War rivalry that fueled and funded the historic Space Age is over.

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